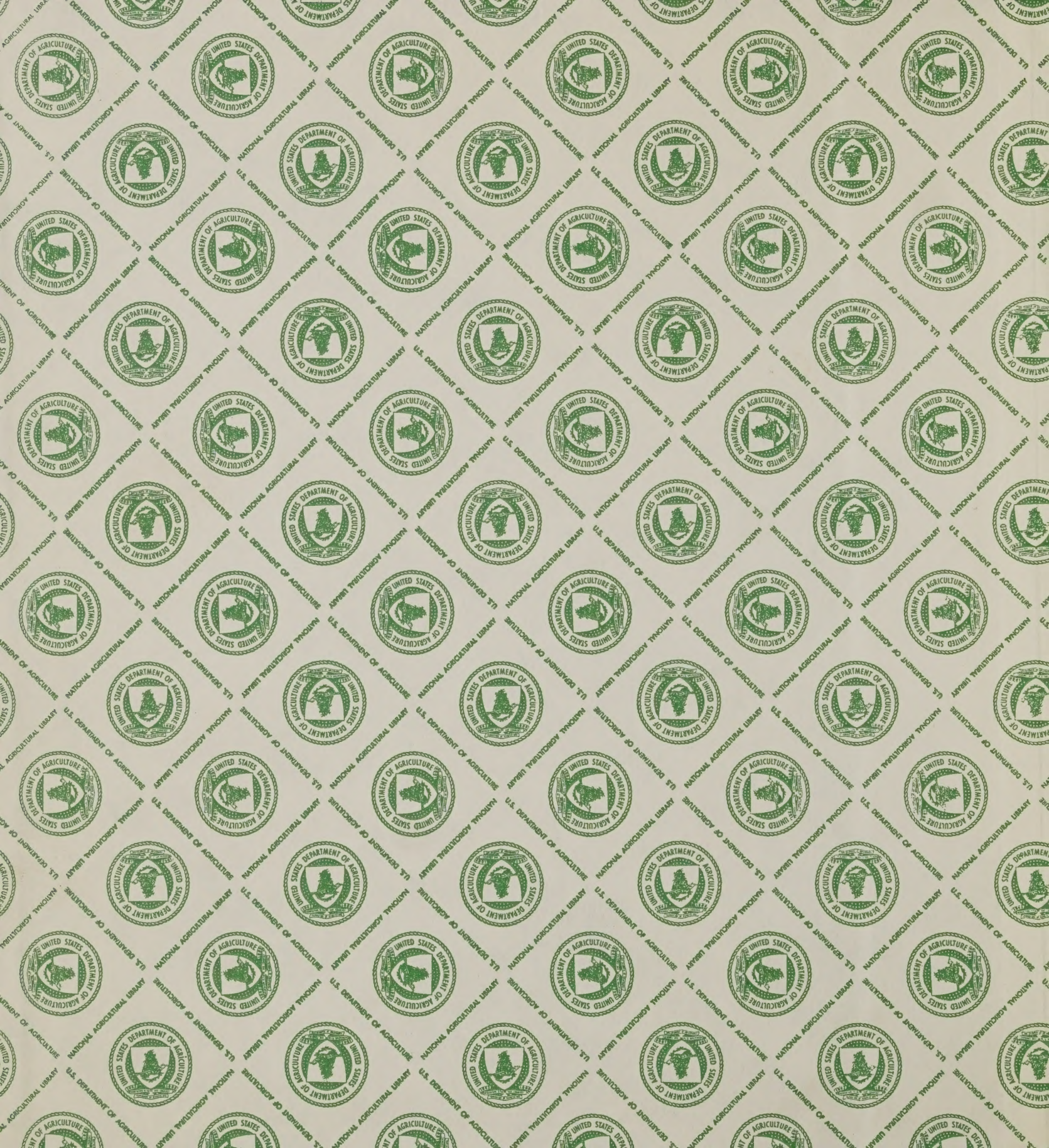
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HANDBOOK OF THE DISEASES OF VEGETABLES OCCURRING UNDER MARKET, STORAGE AND TRANSIT CONDITIONS

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PREFACE

This handbook is designed primarily to aid the inspectors of the Bureau of Markets in the detection and identification of plant diseases as they occur in vegetables under transit, storage, and market conditions.

The entire inspection service and the survey and study of vegetable crop diseases under transit and market conditions, were begun but little more than a year ago, consequently this handbook, an outgrowth of that survey and study, is necessarily incomplete. The text and illustrations are the property of the United States Department of Agriculture, and are not to be used in any published form whatsoever.

The description of the signs, symptoms, or effects of each plant disease is followed by a statement of the geographic distribution and the seasonal or climatic relations of the disease so far as they are known, since some diseases occur only in certain districts and often only under certain conditions.

A statement is made as to the time and place of inception, development, and spread of the disease. This is especially important from a market point of view. For example, in placing the responsibility for the poor condition of a shipment caused by bacteria or fungi, it is essential to bear in mind that some diseases are field infections and do not develop nor spread in transit or storage; that others are field infections which develop or progress but do not spread in transit or storage; that others are field infections which develop and spread under transit and storage conditions; and finally that a number are transit and storage infections of stock perfectly sound when harvested.

It is fully realized that at present not all decay can be referred to clearly defined causes. However, by specifying whenever possible the disease responsible for the decay or defect in a consignment, the inspector can further the con-

* An introductory discussion of the normal and diseased plant is presented, including definitions of the technical terms used in this text and in other literature dealing with plant diseases.

[1] Dr. V. B. Stewart was consulted freely in the preparation of the text. In addition, the following men were consulted with reference to special portions as enumerated below: Beans, Mr. W. W. Gilbert and Mr. G. A. Meckstroth; cabbage and other crucifers, Dr. L. L. Harter and Dr. L. O. Kunkel; celery, Dr. I. C. Jagger; cucumber, Mr. W. W. Gilbert and Mr. W. N. Ankeney; potato, Dr. H. A. Edson, Prof. L. R. Jones, Dr. L. O. Kunkel, Dr. W. A. Orton, Mr. M. Shapovalov, Mr. E. S. Schultz, and Dr. H. G. MacMillan; onion, Dr. J. C. Walker; lettuce, spinach, radish, etc., Dr. I. C. Jagger, Mr. J. B. Norton and Mr. L. P. Byars; tomato, Mr. G. H. Godfrey, Mr. F. J. Pritchard, Dr. J. Rosenbaum and Mr. W. B. Clark; watermelon, Mr. F. C. Meier; sweet potato, Dr. L. L. Harter and Dr. J. L. Weimer.

trol and prevention of diseases, with the resultant improvement of American agriculture and the elimination of waste.

Inspectors should make it a point to send in material concerning which they are in doubt. By doing this they will aid themselves in acquiring a better acquaintance with the various diseases, and will aid in the detection of new diseases or of the occurrence of diseases in regions from which they have not been previously reported. Cartons and franked tags will be supplied the inspectors for use in sending such material. Many specimens can best be sent wrapped in paper (newspaper does admirably). It is very important that material be mailed without delay.

INTRODUCTION.

THE NORMAL PLANT.

Plants and Plant Parts Are Living.

VEGETABLES and fruits are plants or plant parts and are alive. Few people realize that a potato, an onion, an apple, or other fruit or vegetable is alive and is therefore subject to injury, disease, and death. Failure to realize this fact is responsible for much of the loss in the handling of fruits and vegetables.

The Structure of Plants.

Our agricultural plants are composed of members or organs, such as the root, stem, leaf, flower, and fruit. These organs in turn are composed of tissues, the stem, for example, usually being composed of pith, ring, and bark tissue. Tissues, finally, are made up of cells, which are microscopic in size.

Plant tissues often are classified according to their functions. There are, for example, the protective tissues, the supporting tissues, the conductive tissues, the food-making tissues, and the storage tissues.

The Plant Cell and Tissues.

The cell is the unit of composition, structure, and function of all plants. It is composed of the living substance protoplasm, together with its products and inclusions. One of the products of the jelly-like protoplasm is the rigid cell wall in which it encases itself and which gives shape and rigidity to the cell and to the tissues. Tissues and cell walls often remain intact long after the protoplasm has died. In some diseases, the cementing substance which holds adjoining cells together is dissolved out, and disintegration of the tissue results. In other cases the cell walls are punctured and the protoplasm is killed. Chemical analysis of plant tissues, which are, of course, composed of cells, yields principally water, proteins, carbohydrates, fats, and salts. Water is by far the most abundant single constituent, most plant tissues containing 70-75 per cent water.

The structure of plant tissues is roughly comparable to that of honeycomb except that the cells of plant tissues are not as closely packed as those of honeycomb. There are spaces between plant cells, called intercellular spaces, which are most marked in leafy tissues. These constitute the ventilation system of the plant, and through them the cells are in communication with the air.

The epidermis or outermost protective layer of cells of leaves and young stems and roots has many minute openings or breathing pores, the stomata. Through these, water

vapor from the moist intercellular spaces escapes into the air, and carbon dioxide and oxygen exchange between the cells and the air takes place. The loss of water by the living plant through evaporation is known as transpiration.

When unbroken, the epidermis prevents excessive loss of water from the moist tissues underneath and keeps out foreign organisms such as fungi and bacteria. In older stems and roots, such as the Irish potato, the protective covering is composed of cork layers, in which the breathing pores are present as lenticels.

The supporting tissues, such as the veins of leaves or the fibers of stems, are composed of woody or thickened cells. The conducting tissues, found in the veins of leaves or the ring tissues of stems or roots, translocate the water and minerals taken in by the absorptive tissues of the roots, and the food made in the food-making tissues.

The green color of vegetation is due to a substance known as leafgreen or chlorophyll. By virtue of chlorophyll, and with the aid of sunlight, the green tissues of plants are able to manufacture carbohydrates (sugars and starches) from the carbon dioxide of the air and the water of the soil.

These carbohydrates are the basic substances from which the other principal food of plants and animals, such as fats, oils, and proteins, are manufactured by green and non-green cells.

Many plants possess tissues in which they accumulate excess food materials. These are the storage tissues. The Irish potato and the sweet potato are to a large degree composed of storage cells in which starch and sugar, respectively, are stored.

Digestion and Respiration.

The stored food of the potato is in the form of starch grains. In the spring when the potato sprouts, the insoluble starch is changed to soluble sugar, to which is due the sweet taste of potatoes at that season. In ripening plant tissues, insoluble, unpalatable substances, such as starch and tannins, become soluble, aromatic, and palatable.

Another process which goes on in all protoplasm, plant or animal, is respiration. The making of food out of simple materials is a constructive process, whereas respiration is destructive. In its simplest form, it involves a consumption of oxygen, a burning or oxidation of the substances of the cell, such as sugar, starch, fat, and proteins, and a liberation of carbon dioxide gas, water, and energy. Part of this energy is manifested as heat. The so-called "heating" of crops in transit and storage generally is due to the heat evolved in respiration.

The rate of respiration is greatly influenced by temperature. At high temperatures, respiration proceeds at a rapid rate, and the food substances are soon burned up. At low temperatures, the rate of respiration is so retarded that it

* Most plant foods are stored in an insoluble form, and must be rendered soluble before they can be moved from storage places and utilized by the protoplasm. The process of rendering them soluble is digestion and is accomplished by ferments or enzymes.

becomes practically negligible. Proper aeration is essential for the continued life and respiration of vegetables. The carbon dioxide liberated must be removed, and the necessary oxygen must be supplied. If respiring cells are not properly aerated, they die, and spoil.

The fundamental reason for the refrigeration of fruits and vegetables is based upon the fact that refrigeration retards respiration and digestion; retards not only the ripening processes of fruits and vegetables, but also their decay, which is due to the activity of bacteria and fungi.

Relation of the Plant to Its Environment.

The continued existence of protoplasm and therefore of plants themselves is dependent upon external factors which constitute the environment of plants. Some of these are non-living, such as moisture, heat, light, and the air; others are living, such as other plants, or animals. The environment of a plant may vary within certain limits without injury to the plant. However, if these limits are exceeded for a sufficient period of time the plant becomes abnormal or diseased and eventually may die.

When plants or plant parts are shipped and stored as fresh food products, they are subjected to conditions very unlike those prevailing in the field, and care must be exercised to make these such that the life of the plant or plant parts is still possible. This means that the external conditions must be controlled and kept within the narrow range tolerated by the plant in question. Each crop must be handled in a manner suited to its peculiar requirements. This will depend upon the climatic conditions prevailing during the growing season and at harvest; upon the methods employed for culture and harvesting; upon the presence of climatic or mechanical injuries; upon the maturity at harvesting; upon the method of packing or loading; upon the type of container; upon the length of the transportation and storage periods; upon the season, and upon the climatic conditions to which the crop will be subjected in transit. Failure to provide proper conditions for plants or plant parts in transit or storage results in the loss, annually, of thousands of cars of fruits and vegetables. It may result merely in an inferior product so far as appearance and taste are concerned, or in partial or complete decay.

The Relation of Plant Functions to Keeping Quality.

It is well known that vegetables and fruits shrink in transit and storage. Some of the shrinkage is due to readjustment in the pack or load. There is in addition to this, however, a real decrease in the weight and volume of the crops as can be determined by weighing and measurement.

Usually there is a very considerable shrinkage immediately following the harvesting of a crop, due mainly to the

loss of water vapor by the plant through its stomata, or transpiration, and by evaporation from cut surfaces. The loss of water by plant organs is illustrated very strikingly by the phenomenon commonly known as "sweating," which is the result of condensation of this water vapor.

The first result of excessive water loss is known as wilting. Wilting is especially frequent in leafy crops with large transpiring surfaces, such as celery, lettuce, or spinach. The compact, heavy crops such as deciduous and citrus fruits, potatoes, and onions are made up of storage tissues and are much less subject to water loss than the more leafy ones. They lose water much more slowly because of their rather thick protective skin and fewer stomata. They also have a greater bulk of water available in their tissues, and a larger volume of tissue relative to their transpiring surface.

Drying of the surfaces of plants, with a slight wilting of leafy plants, before they are shipped or stored is advisable. Wet plant surfaces favor the development of bacteria and fungi and, when stomata are filled with water, easy ingress is provided for bacteria. Many crops are sweated, cured, or kiln-dried before they are put into storage or shipped, to avoid undue shrinkage by loss of water, and to dry and harden the tissues to render them less subject to attack by bacteria or fungi which flourish on tender tissues under moist conditions. Continued loss of water by plant tissues soon results in their death after which they may become the prey of bacteria and fungi.

Not all of the decrease in weight of fruits and vegetables in storage is due to loss of water. A thoroughly cured sweet potato loses weight and shrinks in storage even when stored in a very humid atmosphere, especially if the temperature is high. A part of this loss is due to transpiration, the remainder to respiration. * At low temperatures, the processes go on very slowly, but ultimately lead to physiological breakdown. In other words, there is a time limit to the storage of all living plant parts. The period is especially brief in the case of succulent crops. Each crop has its period beyond which it is not advisable to store it. For example, a Jonathan apple cannot be stored as long as a Winesap.

Proper aeration and refrigeration are essential in storage places. The former prevents the accumulation of water vapor and attendant sweating, provides oxygen, and removes carbon dioxide. The latter decreases the rate of digestion and respiration in the plant tissue, thus lowering the rate at which the latter consumes itself. More important, however, is the effect of these factors upon the bacteria and fungi which, because of their power to cause decay, are the chief enemies of stored fruits and vegetables. Bacteria and fungi cannot attack plants when the plant surfaces are dry. Furthermore, at low temperatures their activity is so reduced that they seldom attack plant tissues.

* While some of this loss is due to transpiration, most of it is the result of respiration. After fruits and vegetables are harvested they are no longer supplied with new food materials. Since protoplasm respires as long as it is alive, it must oxidize the substances of the cell, the rate depending upon the protoplasm itself and the temperature.

DISEASE IN PLANTS.

* Disease in plants is any deviation from the normal condition of their functions or tissues. **The majority of plant diseases as they occur in the market are localized in their effects and differ therein from most animal diseases, which usually are systemic, and affect the whole body because of the presence of a nervous and a circulatory system.*** For example, the outer leaves of a celery plant may be rotted severely while the inner leaves or heart are in no way injured and are fit for food.() It must be remembered, however, that the sound part of a fruit and vegetable may in some cases acquire a disagreeable odor or flavor from the diseased part. At times even sound fruits or vegetables are affected in taste and flavor by nearby decaying fruits and vegetables.

Types.

Diseases may occur in the growing plant, checking and preventing its growth or its production of normal parts or even killing it outright. They may also occur in fruits and vegetables in transit and storage. We may therefore distinguish between field and transportational diseases, and shall attempt to differentiate as much as possible between diseases which originate in the field and those which originate in transit and storage.

For example, infection of sweet potatoes with soft rot or peaches with brown rot may occur either in the field, in transit, or in storage, whereas infection of sweet potatoes with scurf or peaches with scab occurs only in the field. The first two diseases, however, may develop or progress in the field, in transit, or in storage, whereas the latter two probably do not develop or spread in transit or in storage.

Symptoms.

The signs or characteristics of a disease which mark it and by which its presence is discerned, are known as the symptoms of the disease. During the progress of a disease, its symptoms may change. Frequently there are early and advanced symptoms. The early symptoms of watermelon anthracnose, for example, are raised welts on the rind, while the advanced symptoms are deeply sunken lesions with a salmon pink covering of spores.

Not all the symptoms of a disease necessary for its diagnosis may appear on one specimen. As a matter of fact, it is often impossible to diagnose a disease by examining a single specimen, and a correct diagnosis often involves an examination of the whole field or the entire lot in the car or in storage. In a shipment of celery, for example, some plants may show a watery rot. This condition alone may be insufficient for a correct and complete diagnosis. Other plants in the same shipment may show a white cottony

* After this discussion of the normal plant we are in a position to consider disease in plants.
** Disease is a condition, not a thing. From the market point of view, we are particularly concerned with such deviations as threaten the life of the plant or decrease its economic usefulness by impairing its keeping qualities or destroying its food values.
*** For this reason many diseased regions in fruits and vegetables can be cut out and the remaining healthy tissue used for food.
() However, the presence of diseased parts is a potential danger to the sound ones because of the progressive nature of the disease.

growth of mold and no rot, while others may show the mold and black masses of the fungus. The presence of all of these symptoms in a package or car, however, furnish the basis for a correct diagnosis of the rot as watery soft rot due to Sclerotinia.

Very frequently the symptoms of several diseases appear on the same specimen or in the same lot. A single potato may show symptoms of black scurf, black heart, and Fusarium tuber rot at the same time. Sometimes the symptoms of one disease are followed immediately by those of another, as in black heart of potatoes followed by slimy soft rot.

Diseases Due to Living, Parasitic Agencies.

Most plant diseases are caused by one of two types of minute plant life, commonly known as germs and molds and often referred to collectively as "microorganisms." *

Host and Parasite.

The plant attacked and at whose expense the bacteria or fungi feed, and upon and in which they live, is known as the host. Bacteria or fungi living upon and at the expense of a living plant or animal are known as parasites. When these live upon dead plant or animal matter they are classed as saprophytes. Some bacteria and fungi are restricted to a single host; others can attack a variety of hosts. Diseases due to the latter type of organisms are more likely to originate in transit and storage than those due to the former type.

Bacteria and Fungi.

Bacteria are exceedingly small, single-celled, non-green plants which multiply by simple division. Under proper conditions of temperature, moisture, and food supply, bacteria multiply with astounding rapidity.

Some fungi also are composed of single cells, but most of them consist of many cells united end to end to form threads. A single thread is known as a hypha (plural hyphae) and the mass of hyphae of a fungus is known as the mycelium. Generally the mycelium grows within the tissues of the host and is invisible, although under favorable conditions it may also grow out on the surface. At times the mycelium of some fungi form thickened, hardened masses known as sclerotia.

Fungi generally reproduce by the formation and liberation of special cells or groups of cells called spores. In function, these spores are the equivalent of the seed of higher plants, and are distributed as these are, by man, animals, wind, and water. They are, of course, distributed very much more readily and widely because they are so small and light. The spores of some fungi, such as "blue mold" or "bread mold" are found everywhere. Fungous spores may be "winter" or "summer" spores. Under proper conditions of temperature and moisture these fungous spores germinate or start to grow giving rise to new fungous colonies.

*Germs are technically known as bacteria (singular, bacterium), molds as fungi (singular, fungus)

Fungi bear their spores in various ways. In the simpler types the spores are borne on the surface of the attacked plant as a powdery or dusty covering such as one sees in blue mold (Penicillium) and gray mold (Botrytis). Some, such as Rhizopus nigricans, bear their spores in special cases called sporangia, (singular, sporangium). The summer spores of many fungi are known as conidia (singular, conidium).

In other fungi, spores are produced in slimy heaps on little pads or cushionlike bodies known as acervuli (singular, acervulus). These are especially marked in the anthracnoses. Still other fungi bear their spores in special flask-shaped bodies on or at the surface of the diseased portion of the attacked plant. These appear as dots, or pimple-like bodies and are known as pycnidia (singular, pycnidium). They are conspicuous in the late blight spots on celery, the fruit rot of egg plant, the Phoma rot of tomatoes, and the black rot of apples. The special spore-bearing structures of fungi are known as fruiting bodies. The fruiting bodies which result from fertilization and contain the winter spores do not occur generally under market and storage conditions.

There are four classes of fungi, Phycomycetes, Ascomycetes, Fungi Imperfecti, and Basidiomycetes. Most of the fungi with which we will deal belong to the third of these groups. *

The Life Processes of Bacteria and Fungi.

The protoplasm of bacteria and fungi lacks chlorophyll and therefore cannot manufacture its own food, but must obtain it from green plants, either directly or indirectly. It obtains its food and energy by digestive and respiratory processes from the tissue attacked. This digestive and respiratory action of bacteria and fungi is popularly known as fermentation. Bacterial rots generally are accompanied by putrefactive odors due to the breaking down of protein compounds.

The attack upon living tissues by parasites leads to a disturbance in the functions, structure, and composition of the attacked plant, in other words, to disease. The diseased areas produced by parasites or other causes are known as lesions. At present only those produced by the action of parasites will be considered. A lesion may be a leaf or pod-spot, a wart, a soft or dry-rot, or a canker, depending upon the parasite, the external conditions, and the nature and response of the affected host tissues. Soft rot of the carrot, for example, consists of lesions caused by *Bacillus carotovorus*. These bacteria secrete ferments or enzymes which digest or dissolve the cementing substances between the carrot cells and disintegrate the tissue into a soft, slimy mass.

In other diseases the lesions arise in a different manner. In anthracnose of the cucumber, for example, the hyphae

*In addition the myxomycetes or slime molds and schizomycetes or bacteria are sometimes considered as fungi. Consequently we often see the phrase "bacteria and higher fungi" or bacteria and hyphal fungi".

of the fungus, Colletotrichum lagenarium, penetrate the cell walls and feed upon the protoplasm. As a result, the affected cells die and lose their water, consequently one of the first symptoms of the disease is a water-soaked spot on the fruit. Since the water evaporates rapidly from this spot, it dries out and becomes sunken. As more cells are killed and the lesion enlarges, cavities result from the shrinkage and rupture of the killed tissue. In other diseases, such as late blight of the potato, the fungus grows between the cells and sends suckers into the cells, thereby securing its nourishment, and eventually killing the host protoplasm.

The activity of the bacteria and fungi, like that of other plants, is greatly influenced by temperature. Low temperatures inhibit the germination and growth of these parasites, consequently are useful in controlling many diseases. Low temperatures also retard digestion and respiration in these organisms, consequently decrease their destructive activities. These facts are fundamental reasons for the refrigeration of fruits and vegetables. Control of the life processes of these organisms by low temperatures probably is more important than the effect of refrigeration upon the life activities of the stored fruits or vegetables. Some fungi and bacteria can grow well at moderate temperatures and consequently are very active even in iced cars. Scletotinia, for example, grows well at moderate temperatures and therefore causes a rot of celery in iced cars.

Active bacterial and fungous cells do not possess the effective protective tissues of higher plants, consequently their protoplasm is very subject to drying out. In the desiccated state these organisms are inactive or resting, and cannot resume growth or develop so long as they are dry. In combating diseases caused by parasites, it is fundamentally important to recognize the fact that a moist environment is essential for their growth and spread. Dried or slightly wilted plant tissues, when shipped or stored in a well aerated place, are not attacked readily by bacteria and fungi. Loading or storing wet fruits or vegetables often leads to disastrous results because of the action of micro-organisms.

Inception of Diseases Due to Bacteria and Fungi.

While bacterial cells and fungous spores are everywhere present in great numbers on the exposed surfaces of all normal uninjured plant parts, the interior tissue is usually absolutely sterile; that is, free from all foreign organisms.

Before disease can occur infection must take place. By infection we mean the entrance of the disease-producing organism into the host tissue and its development therein. Plants are protected against the entrance of foreign organisms by their epidermis, by their cork layers, and by the nature of their protoplasm. Foreign organisms may gain entrance through the unbroken skin, or through natural openings in the epidermis such as stomata and water pores.

However they generally enter plant tissues through wounds or abrasions of the protective layers. This type of infection is the most important in transportational diseases. Injured or dead areas offer an excellent foothold for rot-producing organisms.

Diseases Due to Non-living, Non-parasitic Causes.

A very considerable number of plant diseases are due not to parasitic organisms but to other unfavorable factors in the environment of the plants. Water core and Jonathan spot of apples, black heart, hollow heart, and sunburn of potatoes, tip-burn of lettuce and other crops, and scald and freezing or chilling injury of vegetables and fruits are excellent examples of disease due to non-parasitic causes.

Tip-burn of lettuce and other plants, water core and Jonathan spot of apples, and blossom-end rot of tomatoes and watermelons probably are due to irregularities in the water relations of these crops. The nature of the plants themselves is also a very important factor in such troubles. For example, with the same soil and climatic conditions, the same water supply, and the same treatment of trees of various varieties, the Jonathan and the Grimes Golden alone may show Jonathan spot. Black heart of potatoes is a good example of the evil effects of disturbed respiration in plants.

Under normal conditions, oxygen enters the internal tissues of the potato at a rate sufficiently rapid to maintain normal respiration. However, if the temperature is raised to 100° F., the rate of respiration is so increased that oxygen cannot penetrate to the inner cells rapidly enough to supply their needs. As a result the internal tissues of the tuber become asphyxiated, die, and turn black.

If potates are kept at normal temperatures but are not well aerated and do not have a normal supply of oxygen, black heart also results. In this case the death and discoloration of the cells is not restricted to the heart of the potato.

Chilling and freezing injury are good examples of the effects of excessively low temperature upon plant tissues, while sunscald is an example of the effect of extremely high temperature. Either extreme kills the tissues.

Tolerance, Resistance and Predisposition to Disease.

Many plants have to a certain degree an ability to tolerate unfavorable climatic, soil, and cultural conditions, and to withstand or tolerate the attacks of bacteria and fungi. This tolerance varies with the age and variety of the plant and with the conditions under which the plant is grown.

Resistance to parasitic attack may be due to the nature and thickness of the protective covering of the plant, to a scarcity of natural openings, to the rapidity with which wounds heal over (with wound cork), to the time of ma-

turity of the plant, to the acidity of its tissues, or more commonly to some unknown factor in the composition of the protoplasm of the cells themselves.

Disease Control.

By disease control is meant the elimination, the checking, or the prevention of a disease. Plant diseases usually are controlled by prevention rather than cure. A very generally used method in the control of diseases due to parasites is the spraying, dusting, or dipping of plants or plant parts to kill the fungi and bacteria present on the surfaces, or to prevent the germination of spores that may lodge thereon subsequently. There are a number of other practical methods of disease control, such as proper cultural methods, crop rotation, soil and seed sanitation, planting of disease-free stock or disease-resistant varieties, and the variation of the planting date.

In the control of transportational diseases, icing, refrigeration, ventilation, precaution not to pack wet plants or plant organs, drying of plants, and careful handling are important means of disease control.

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ONION

PARSNIP

RUTABAGA

GRAY MOLD ROT

GRAY MOLD ROT

OF ARTICHOKE, BEET, CABBAGE, CARROT, CAULIFLOWER, CITRON, LETTUCE, ONION, PARSNIP, RHUBARB, RUTABAGA, SALSIFY, SHALLOTS, TURNIP, AND OTHER VEGETABLES.

Cause: A fungus (Botrytis).

This is a semi-watery to watery soft rot characterized externally by a gray velvety fungous growth. Frequently there is a slight tinge of green or brown in the gray color of this mold. At times gray to black solid masses known as sclerotia are produced on the affected tissues as in the case of the gray mold rot of onions generally known as "neck rot."

Gray mold rot can be differentiated from the watery soft rot caused by Sclerotinia by the gray color of the mold and by the absence of a cottony mycelium.

Gray mold rot can be differentiated from slimy soft rot by the gray fungous growth and by the absence of offensive odors. Rhizopus rot can be differentiated from gray mold rot by its abundant stringy and coarse mycelium, its sporangia, and its sour odor.

In case of doubt as to the identity of a given rot, it is advisable to collect and incubate some material in a warm damp-chamber secured either by wrapping it in paper or by placing it in covered pans. If a mycelium develops within 24 hours, the rot is not slimy soft rot. If a white cottony mycelium develops which later becomes matted, the fungus is probably Sclerotinia. A grayish, powdery fungous growth indicates Botrytis, and a stringy mycelium with sporangia, Rhizopus. The presence of sclerotia will further indicate either Sclerotinia or Botrytis.

Often the watery soft rot due to Sclerotinia and the gray mold rot due to Botrytis occur either together or in close succession on the same specimen.

Gray mold rot does not progress as rapidly as watery soft rot and, like slimy soft rot, may be checked by drying affected tissues, while watery soft rot (due to Sclerotinia) progresses rapidly even under dry atmospheric conditions.

Infection takes place in the field, in transit, and in storage since the spores of the fungus seem to be everywhere present. The fungus may develop in the field if moist weather prevails.

The rot occurs commonly in mature tissues kept in a very humid atmosphere. It attacks frozen or bruised tissues very readily.

Affected stock may be made marketable if trimmed and kept in a dry, well-ventilated place. It is not safe to store affected stock because it is a menace to healthy stock, the fungus spreading readily from affected to healthy tissues.

Little is known about the control of this rot, but soil aeration and proper ventilation in transit and storage are preventive measures. The neck rot type of this rot found

on onion bulbs can be checked by rapid curing of the onions as soon as they are dug.
Ref. (48).*

*Reference is made by number to "Literature cited," pp. 13-17.

CABBAGE RHIZOPUS SOFT ROT.

RHIZOPUS ROT.

OF BEAN, BEET, CABBAGE, CARROT, ONION, SQUASH, SWEET POTATO, TOMATO, AND OTHER VEGETABLES.

Cause: A fungus (Rhizopus).

In its early stages, Rhizopus rot consists of soft, water-soaked areas. These enlarge rapidly and often lead to a leaky condition of affected stock. Under proper moisture conditions, there is produced a coarse, white, stringy mycelium bearing white, glistening heads or sporangia, which later turn brown or black. This mycelium is often called "whiskers" because of the long, loose growth of hyphae.

Generally the rot is accompanied by a sour, acid odor, noticeable when the diseased tissue is freshly broken. In carrots, sweet potatoes, and other crops which are rich in starches and sugars, acetic acid is produced, giving rise to a vinegar-like odor. In cabbage lactic acid is produced and an odor of sauer kraut is the result.

This rot is distinguishable from watery soft rot by its sour odor and by the presence of the fluffy, stringy mycelium with its sporangia. The mycelium of Sclerotinia is white and cottony or matted. In advanced stages, the Rhizopus mycelium collapses, becomes matted, and appears gray or brown, but lacks the black sclerotia of Sclerotinia.

The sporangia, the color of the mycelium, and the sour odor of the rot distinguish it from gray mold rot, and the presence of the mycelium distinguishes it from slimy soft rot.

Rhizopus rot is favored by high temperatures. In this respect it differs from watery soft rot or gray mold rot, both of which develop best at moderate temperatures. It is common in overheated, humid cars, especially in the summer, or in refrigerated cars in which the ice was allowed to run low.

Usually the fungus gains entry through wounds. The original infections may take place in the field, in transit, or in storage since the spores of the fungus seem to be everywhere present. The rot develops and spreads very rapidly. Like Sclerotinia, Rhizopus spreads from affected to healthy stock by contact.

Sorting out of bruised stock, drying of moist surfaces, and proper ventilation and refrigeration will act as effective control measures in transit and storage.

SLIMY SOFT ROT.

OF BEAN, BEET, CABBAGE, CARROT, CELERY, LETTUCE, MUSTARD, ONION, POTATO, RADISH, RUTABAGA, SHALLOTS, SPINACH, TURNIP, AND OTHER VEGETABLES.

Cause: Bacteria (Bacillus carotovorus group and other bacteria).

This disease is a soft rot characterized by a slimy, slippery condition of the affected tissues, by a foul odor, and by the absence of fungous growth. The last characteristic differentiates it from rots caused by fungi. Green, leafy tissues affected with slimy soft rot have a very dark green color at first much like hashed spinach but later become brown and black. Light colored tissues, such as cabbage and celery, become yellowish and finally brown.

Slimy soft rot is differentiated from gray mold rot by the absence of the powdery, gray growth of mold and of the gray to black sclerotia characteristic of gray mold rot. The offensive odor of slimy soft rot distinguishes it from the rot due to Rhizopus, which has an acid odor. Tissues affected with slimy soft rot do not leak as do tissues affected with watery soft rot, but become a mass of slime if kept in a moist place. Watery soft rot progresses even in a dry atmosphere after once well started, while the progress of slimy soft rot is arrested by drying of the tissues.

The rot proceeds from any part of the plant, and tissues are predisposed to it by bruising, chilling, freezing, tip-burn, sun-scald or aging. In the case of the southern bunch crops, only the leaves are affected. It is prevalent in root crops whenever tissues have been killed by exposure to extremely wet conditions, by extremely high temperatures, or by freezing. During rainy seasons, slimy soft rot may ruin southern potatoes if they are not dug at once and dried. Future investigations may show that the slimy soft rot of the leafy parts, and the soft mushy rot of the root or stem parts of plants, well marked in carrots and cabbage, are not caused by the same organism. The rot of the latter sometimes is called the "true soft rot." In carrots that have been in storage, soft rot is often found, the central tissue of the root being most readily attacked. In the north, soft rot is common in cabbage in the field late in the fall, especially where many plants have been weakened or killed by the soil disease known as cabbage yellows. Such rotted heads in the field are a source of danger to sound stock since infection may be carried on the knives used in cutting off the heads. This may account for the common occurrence of the so-called "stump rot" in cabbage in storage or transit.

Slimy soft rot occurs commonly in southern winter-grown bunch crops. It results from infection in the field, in transit or in storage, and develops and spreads under any of these conditions. It is favored by the moist atmosphere prevailing in iced barrels, crates, and hampers in which these crops

SPINACH SLIMY SOFT ROT.

are shipped, and in the cellars and pits in which northern stock, especially cabbage and celery and the root crops, are stored. High temperatures are of even greater importance, however, and greatly accelerate the progress of this rot, especially in potatoes.

Affected stock generally is not marketable, although affected tissues can be trimmed away, leaving the sound remainder salable.

The rot can be controlled by guarding against sun-scald, freezing injury, and excessive bruising, by drying the surfaces of vegetables, especially those cut and bruised, and by maintaining dry and cool conditions in transit and storage.

Ref. Carrot and other vegetables (33); cabbage (26); lettuce (4), (36); onion (67).

WATERY SOFT ROT

WATERY SOFT ROT.

OF ASPARAGUS, BEAN, BEET, CABBAGE, CARROT, CAULIFLOWER, CELERY, LETTUCE, KOHL-RABI, PEPPER, SALSIFY, SHALLOTS, SQUASH, TURNIP, AND RUTABAGA.

Cause: A fungus (Sclerotinia).

This disease is a watery soft rot of the affected tissue characterized by a white, cottony, at times matted, mycelium; by the presence of hard masses or knots (sclerotia) which are white at first and then become purplish black; and by the absence of any offensive odor.

The watery disintegration associated with watery soft rot is often so complete that water runs freely from crates, hampers, and even cars containing affected stock. Due to this loss of water, affected stock may shrink to but a small portion of its original volume.

Affected tissue may seem only slightly discolored and rotted, but upon application of pressure it is noted that the tissue is completely softened and that water escapes with the greatest ease. The slimy feeling noted in connection with the slimy soft rot of succulent tissues is entirely absent.

The affected plants, the containers, and even the car may be overrun by a heavy growth of loose, cottony or matted mycelium, which under proper conditions forms the sclerotia previously mentioned. The fungus often is responsible for the so-called "nesting" of beans.

Affected celery tissue often has a pinkish or rose color, especially in the early stages, and consequently the rot is sometimes known as "pink rot" of celery. At times purplish tints are noticeable. Generally, however, the diseased tissue is yellowish or brown.

In typical field attacks upon lettuce, which are known as lettuce "drop," or upon cabbage, the disease begins on the stalk near the ground, or on the leaves touching the ground, progressing from these to the stalk, which becomes softened and at times entirely destroyed. The result in either case is a collapse of the entire plant. In the field the disease is known as "foot rot" of celery because of the frequent initial attacks at the base of the plant. However, under storage and transit conditions, plants may be attacked at any point. Well headed cabbage or lettuce often remains intact because of the overlapping leaves. Often one finds, however, when an attempt is made to lift an affected head, that it falls to pieces quite unlike plants affected with slimy soft rot which tend to slip out of one's hand.

On root crops the rot is not as watery as on leafy tissues. Under dry conditions, evaporation keeps pace with the liberation of water by the fungus and the affected tissue dries out and shrinks. Thus the watery nature of this rot in roots is not as evident as in the case of leafy or succulent tissues. However, under moist conditions, affected root crops exude water freely. The white cottony or matted

mycelium and the black sclerotia serve to identify the disease on root crops when the watery characteristics are absent.

This rot can be differentiated from slimy soft rot by the fact that the latter is a slimy, slippery decay usually accompanied by a bad odor and lacks the white mycelium and large sclerotia of watery soft rot. The latter can be differentiated from gray mold rot by the typical powdery gray moldy outgrowth of the latter. Gray mold rot is generally found on overmature tissues, and is not as watery as the typical watery soft rot caused by Sclerotinia. Watery soft rot progresses at lower temperatures than does the soft rot induced by Rhizopus. Rhizopus rot is prevalent in the summer and in overheated cars in the winter, while watery soft rot develops in refrigerated cars.

The disease is favored by high humidity and moderate temperatures. The original infection proceeds from the soil. Lettuce grown under glass, or plants grown in crowded quarters, are especially subject to infection. The disease develops and spreads very rapidly in transit and storage, the fungus passing from diseased to healthy tissue by contact.

Crop rotation and soil sanitation and aeration are control measures which can be applied in the field. Losses in transit and storage may be reduced by sorting out and discarding diseased plants and by thorough ventilation. After the diseased portions of affected plants are trimmed off, the remainder is edible. It is not advisable to store trimmed plants.

Ref.: Lettuce (5); (65); (66).

CUCUMBER

PEPPER

ONION

SUN-SCALD

SUN-SCALD.

OF CUCUMBER, HONEY DEW MELON, ONION, PEPPER, POTATO, TOMATO, AND WATERMELON.

Cause: Exposure to the hot sun.

Sun-scald is evidenced by the death and discoloration of a rather extensive area on the exposed surface of the vegetable. In most cases, the lesion is irregular in outline and at first resembles a water-soaked blister, but soon becomes slightly but sharply sunken and distinctly bleached in color. This bleaching is particularly noticeable in peppers, tomatoes, and cucumbers.

Sun-scald is particularly important from the market standpoint because the scalded areas are very subject to the attacks of rot-producing bacteria and fungi. On onions, scald may be followed by slimy soft rot, and large losses were thus incurred in certain shipments from Stockton, Cal., in 1918. Tomato scald opens the way for fungous rots and was an important factor in the losses in Texas and Tennessee shipments in 1918. Sun-scalded muskmelons or watermelons are frequently invaded by saprophytic fungi such as black mold (Sterigmatocystis) and Cladosporium or Alternaria. Generally these are surface growths more or less confined to the dead tissue.

Potato scald is discussed elsewhere, as is also sun-scald of bean.

Because of its predisposition to rot during transit, scalded stock could profitably be culled out before shipment.

NEMATODE DISEASE.

OF BEET, CARROT, CELERY, PARSNIP, POTATO, SWEET POTATO, RADISH, RUTABAGA, AND TURNIP

Cause: A nematode or eelworm (Heterodera radicicola).

This disease affects the underground parts of plants. It may be recognized on tubers by small, pimple-like swellings or by larger protuberances of the surface, which ordinarily becomes roughened at the infected places. These swellings when some distance apart are circular, but if occurring close together they take on various shapes and sizes. On roots the disease appears as definite galls or knots and consequently is commonly called root-knot.

Eelworm-infected tubers and roots sometimes are confused with those affected by other diseases (crown-gall of beets, club-root of crucifers, and "pimply potatoes" due to flea-beetle injury), which also cause a swelling of the diseased tissues. The nematode disease, however, may usually be readily distinguished from other maladies by the presence of small, white, pear-shaped nematodes, the adult females, which may barely be seen with the unaided eye when well-infested tissues are broken or teased apart.

This disease occurs widely in most of the older trucking sections of the southern portions of the United States and in greenhouses everywhere.

Plants become infected in the field. The disease does not develop or spread in transit or storage. Diseased stock, however, is very subject to invasion by secondary organisms, particularly bacteria.

Affected stock may largely be eliminated by grading. It never should be shipped, not only because it is unsightly in appearance, of inferior quality, and impaired in market value, but also because it may carry the disease into uninfested regions.

Ref. (1a).

GRAY MOLD ROT : CARROT
ARTICHOKE (BELOW)

ARTICHOKE: GRAY MOLD ROT; BOTRYTIS ROT.
(See Gray Mold Rot).

ASPARAGUS: SLIMY SOFT ROT; BACTERIAL ROT.
(See Slimy Soft Rot).

ASPARAGUS: WATERY SOFT ROT; SCLEROTINIA ROT.
(See Watery Soft Rot).

BEAN ANTHRACNOSE.

BEAN: ANTHRACNOSE.

Cause: A fungus (Colletotrichum lindemuthianum).

Anthracnose is marked in the very early stages by minute oval or circular spots which are maroon to reddish in color. These spots are not water-soaked as in the bacterial blight. They form ulcer-like lesions, which increase rapidly in size and, though circular, often coalesce to form large irregular spots. Very soon, often in 24 hours, the spot becomes darker in color, the central tissue dries up and shrinks, and a depressed, considerably sunken spot results, with a black center and generally a reddish border. Under moist conditions the dark center of the spot becomes covered with orange-pink dots or spore heaps which may run together and form a slimy layer. These spore heaps are borne on cushions known as acervuli (singular, acervulus). The border of the lesion is sharply marked, especially on the wax pod varieties.

From pod lesions the fungus often enters the seeds. In case of light attack the seed shows only a yellowish spot. In severe cases the spots are yellowish, brownish, or black, and circular or irregular in shape, and are surrounded by a reddish zone. They may be sunken, but rarely show the pinkish slime noted on the pod spots. The spots on the seed are darker colored and more definitely marked than those of bacterial blight.

Anthracnose occurs in all varieties of wax pod, green pod, pole, navy, kidney, lima, and some scarlet runner beans. Its development is favored by moderately cool weather, and its spread, by wet weather. Since it is carried in the seed, the disease may occur in any bean-growing section, but the regions subject to cool, wet weather are most seriously affected. It is least prevalent in the Rocky Mountain and Pacific Coast States.

The original infection takes place in the field where both the vines and pods are affected. The disease develops on the pods in transit, and may spread under very moist conditions.

Crop rotation and the use of disease-free seed or disease-escaping varieties are the only known effective control measures. Seed grown in hot, dry regions is comparatively free from anthracnose.

Ref. (76); (14); (47).

BEAN BLIGHT.

BEAN: BACTERIAL BLIGHT.

Cause: Bacteria (Pseudomonas phaseoli).

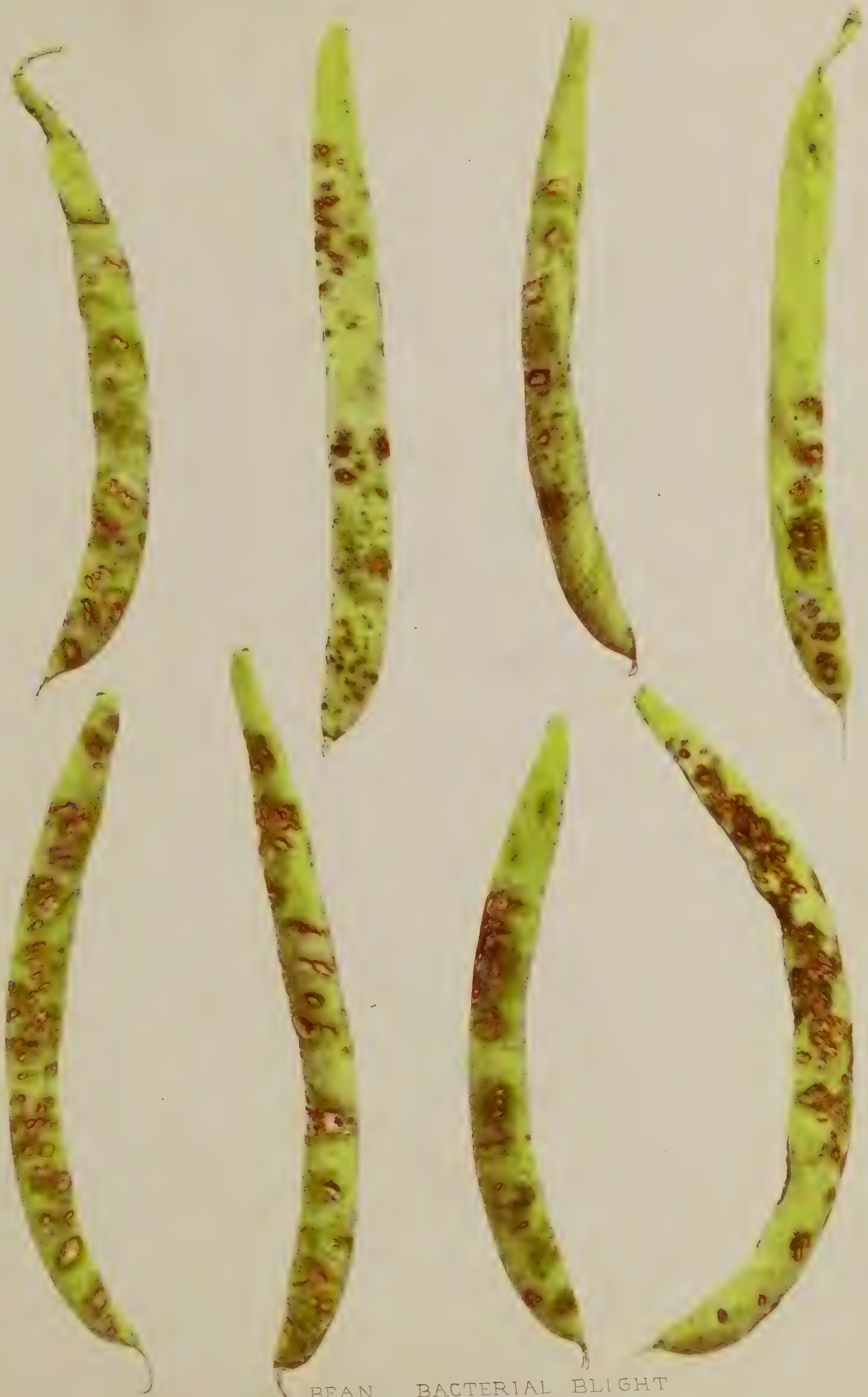
In the early stages bacterial blight is marked by small, water-soaked spots on the pods. These gradually enlarge and become irregular in shape, the green color fading as the affected tissue dries out. The lesions may have an elevated margin. Very soon the spots become reddish brown, first at the margins and then in the centers. Finally they turn a darker brown. In this stage the spot dries out and becomes sunken. Under moist conditions, a slime oozes out from the surface of the water-soaked spots. When dry, this exudate forms a translucent or yellow crust. The border between healthy and diseased tissue is not as sharply marked as in bean anthracnose, and is more irregular. The presence of the exudate and the irregular shape of the lesion usually serve to identify blight.

The bacteria from the pod lesions may penetrate and infect the seeds. Such seeds are marked by yellow spots or blotches of irregular shape or by surface crusts of a yellowish color. These spots may show dark red borders and at times a brown or black color. Seeds often are completely yellowed and shriveled.

Bacterial blight occurs in all bean districts east of the Rocky Mountains. Its spread is favored by moist warm weather, though it can develop in dry weather. It causes severe blighting of the foliage, and may kill plants outright. Pod infection takes place in the field, but the spots may develop or enlarge in transit, and may predispose the stock to slimy soft rot or watery soft rot.

Blight is a seed-borne infection, and may be controlled only by the use of disease-free seed and the practice of crop rotation.

Ref. (15); (75).



BEAN BACTERIAL BLIGHT

BEAN SOIL ROT.

BEAN: SOIL ROT.

Cause: A fungus (Rhizoctonia).

Soil rot is characterized by large lesions generally near the end of the pod or at points where the pod has been in contact with the ground. The lesions are large and irregular in shape and light brown in color with soft, badly-rotted underlying tissues. At times the spots are concentrically marked. Anthracnose lesions are smaller and more regular in shape.

Soil rot occurs only in very moist seasons. The original infection takes place in the field. The fungus spreads from diseased to healthy pods in transit under moist conditions and often causes severe "nesting." The coarse, brown hyphae of the fungus and the sclerotia, if present, distinguish soil rot from the watery soft rot induced by Sclerotinia and from the rot caused by Rhizopus, both of which also cause "nesting."

Soil rot is controllable by careful sorting of the stock and by maintaining a low temperature and humidity during transit.

BEAN: RUSSET.

Cause: Unknown. Non-parasitic.

Russet is a rather prevalent chestnut-brown surface discoloration of green-pod and occasionally wax-pod beans. The discolored areas are of various shapes and sizes, sometimes involving nearly all of the pod. The affected tissue is firm and sound, and is not at all sunken. The discoloration is due to the death of the three or four outer layers of cells.

This disease seems to appear in beans that have been in transit or storage for some time, and is probably not of field origin. Russet is common in Florida beans in the northern markets. It is objectionable because of the injury to the appearance of affected stock.

No control is known.

BEAN: SUN-SCALD.

Cause: Exposure to the hot sun.

This injury first shows up on the exposed side of the pod as minute brown or reddish parallel streaks, which enlarge and merge to form brown or reddish areas of varying size. Sun-scald is not easily distinguished from bacterial spot, but is more likely to be limited to one side of the pod, and lacks the greasy exudate which often is present on blight lesions.

Sun-scald is due to exposure to the sun, and does not occur where the pods are shaded.

Ref. (41).

LIMA BEAN: POD BLIGHT.

Cause: A fungus (Diaporthe phaseolorum).

In the early stages, this disease is characterized by circular to semi-circular spots of darkened tissue. Later the affected tissue becomes studded with minute, gray elevations. These elevations soon break the skin of the pod, and emerge as black pustules, the fruiting bodies, or pycnidia, of the fungus. The pycnidia may be arranged concentrically or in chain-like fashion. In advanced stages, the entire pod may become diseased and covered with pycnidia.

Pod blight has been reported only in the Northern Atlantic States, and is not common. Infection takes place in the field, and the disease may develop and progress in transit.

Pod blight can be controlled by seed selection and disinfection and by spraying in the field. It is advisable to sort out and not market diseased pods.

Ref. (25).

BEAN RHIZOPUS SOFT ROT.

BEAN: RHIZOPUS ROT.

(See Rhizopus Rot).

BEAN: SLIMY SOFT ROT; BACTERIAL ROT.

(See Slimy Soft Rot).

BEAN WATERY SOFT ROT.

BEAN: WATERY SOFT ROT; SCLEROTINIA ROT.

(See Watery Soft Rot).

BEET SLIMY SOFT ROT OF LEAVES

BEET: BLACK ROT.

Cause: A fungus (Phoma betae).

In this rot, the affected tissue is coal black, rather firm and extends deeply into the root. There is no bad odor. The surface becomes somewhat shrunken, and often bears the black pycnidia of the causal fungus.

This disease causes a leaf spot and a blight of the plants in the field. The fungus is carried with the seed.

Control consists of seed and seed-bed sanitation and removal of diseased leaves from roots previous to storage.

Ref. (17).

BEET: LEAF SPOT.

Cause: A fungus (Cercospora beticola).

This disease occurs only on the leaves where its lesions appear as distinctly circular spots with purple borders and tan to ashen gray centers. Leaves may be killed by the coalescence of numerous lesions. The death of the older leaves may cause the crown to elongate, thus affecting the shape of the root.

Beet leaf spot is widespread in its occurrence and is of considerable economic importance in the field. In the sugar beet crop, it lowers the efficiency of the leaves as sugar producers. In the market, leaf spot predisposes the leaves to the attack of slimy soft rot.

Spraying with Bordeaux mixture will control the disease.

Ref. (40).

BEET: SLIMY SOFT ROT; BACTERIAL ROT.

(See Slimy Soft Rot).

BEET: MISCELLANEOUS DISEASES.

ROOT ROT.

Cause: A fungus (Rhizoctonia).

This rot starts typically from the crown, and progresses downward from the leaf bases.

Ref. (17).

SCAB.

Cause: A fungus (Actinomyces scabies).

Beet scab closely resembles potato scab. Large corky brown excrescences are produced. Sugar beets and mangels are susceptible.

This disease is uncommon in the market.

SALSIFY

WATERY SOFT ROT.

BEET

BEET: GRAY MOLD ROT; BOTRYTIS ROT.

(See Gray Mold Rot).

BEET: WATERY SOFT ROT; SCLEROTINIA ROT.

(See Watery Soft Rot).

BEET: NEMATODE DISEASE.

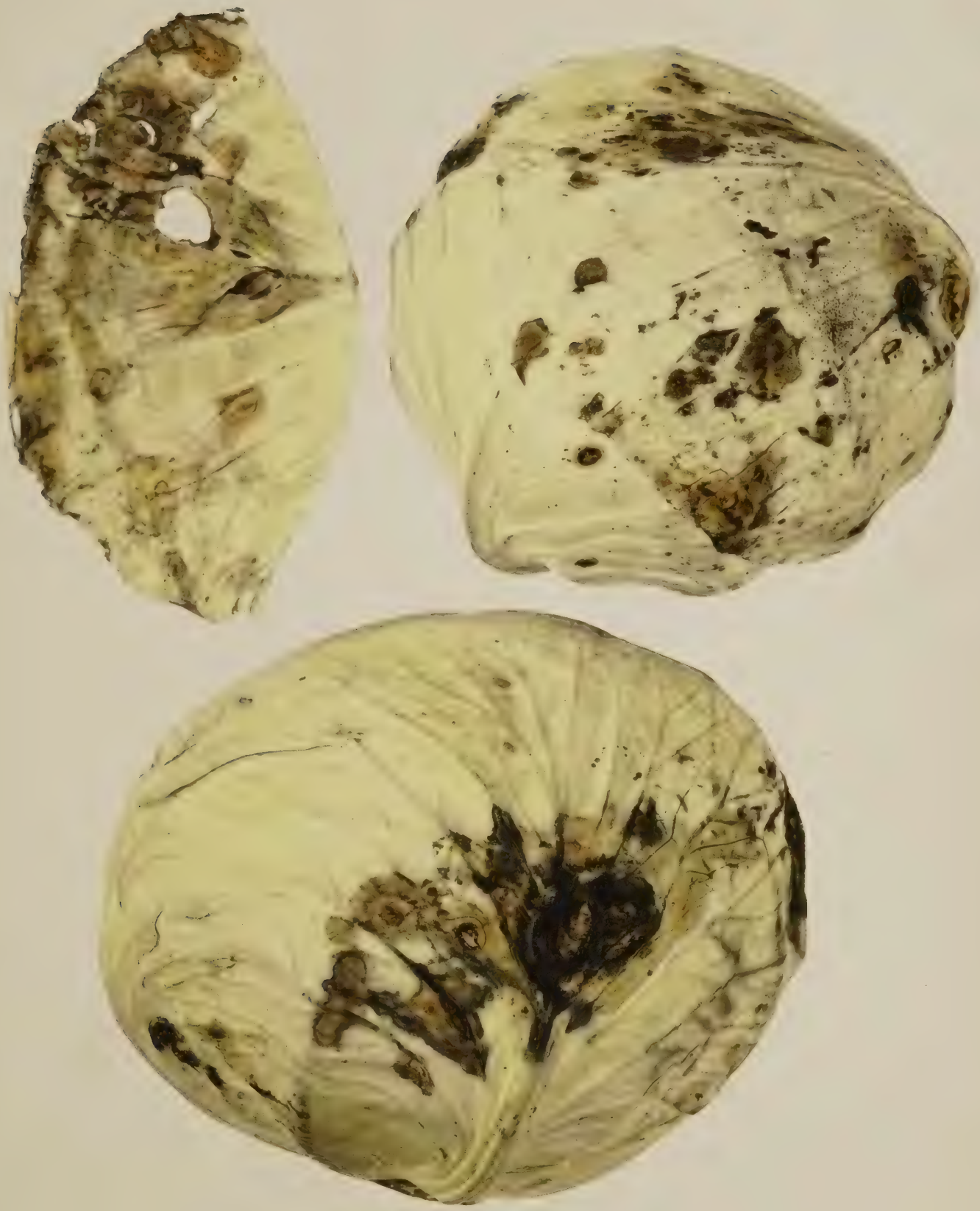
(See Nematode Disease).

BRUSSELS SPROUTS: BLACK LEAF SPOT.

(See Cabbage Black Leaf Spot).

BRUSSELS SPROUTS: RING-SPOT.

(See Cauliflower Ring-Spot).



CABBAGE BLACK LEAF SPOT

CABBAGE: BLACK LEAF SPOT.

Cause: A fungus (Alternaria brassicae).

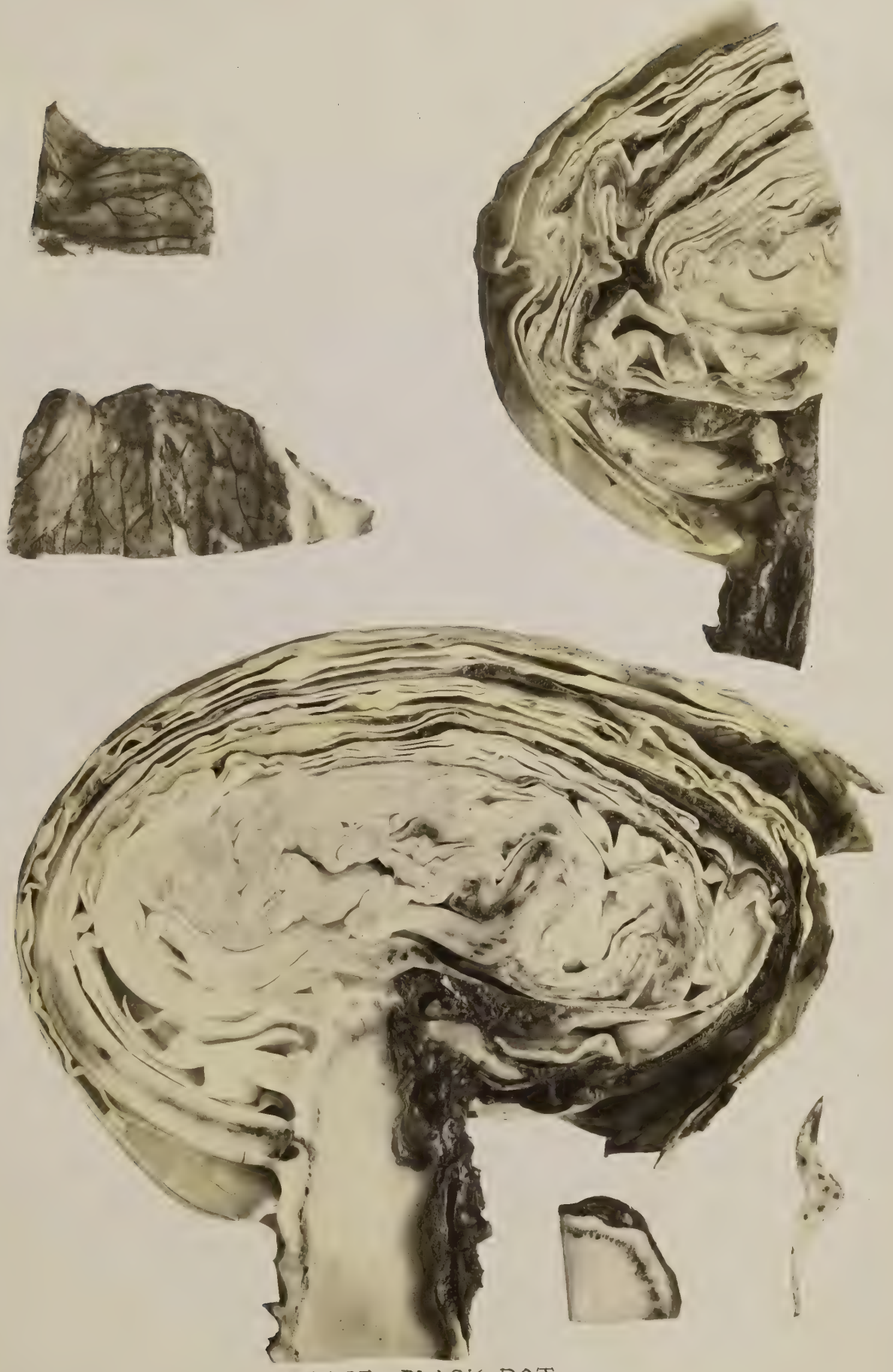
In the early stages, this disease is characterized by minute, circular, shiny, brown to black spots. Later these spots enlarge and lose their circular shape. The lesions generally are somewhat concentrically marked in target fashion and, under moist conditions, may be covered by a growth of brown to black mold. Generally, if affected heads are kept in a dry place, the centers of the spots fall out and leave holes.

The lesions are more pronounced and more common on the outer leaves, but under moist conditions, the fungus may penetrate from leaf to leaf and often may afford points of attack for the bacteria of slimy soft rot.

Infection occurs in the field, and the disease develops in transit and storage.

Disinfection of storage houses, care in handling, and a regulation of temperature and moisture conditions will control the disease in storage. The spots do not render cabbage unfit for transit and storage if the affected leaves are trimmed off.

Ref. (26).



CABBAGE BLACK ROT.

CABBAGE: BLACK ROT.

Cause: Bacteria (Pseudomonas campestris).

Black rot is characterized by a black discoloration of the water-conducting tissue of the plant. Sometimes the discoloration occurs only as a ring in the stalk, but not infrequently it extends into the leaf midrib and veins. This discoloration in the stalk can be seen easily if a fresh section is cut, and its progress into the leaves can be noted by breaking the leaves from the stem, which will reveal a group of black dots in the leaf scars. Badly affected leaves have a steel gray or purplish hue, due to partial masking of the blackened veins by the white or yellowish leaf tissue.

If no secondary rots set in, the disease may show itself as a slowly progressing rot which does not necessarily proceed from the outside leaves as in slimy or watery soft rot, but may appear in the covered leaves, even in the heart of the head. Generally, however, a typical slimy soft rot sets in, proceeding either from the outside or inside, and the head rots rapidly with a very offensive odor.

This disease occurs in all cabbage-growing regions. Infection takes place in the field. The bacteria enter the plant at the margins of the leaves, proceed downward through the veins to the main stalk, and then upward into the head.

The disease develops in transit and storage. Affected stock is very subject to secondary rots, and as a result is a menace to healthy stock.

Control of the disease in the field consists of seed disinfection, seedbed sanitation, and crop rotation. Severely affected stock is unfit for food. It is not advisable to store or ship slightly affected stock.

Ref. (61); (26).

CABBAGE FREEZING INJURY.

CABBAGE: FREEZING INJURY.

Cause: Exposure to low temperatures.

Freezing injury is marked by a glassy yellowish appearance of the affected tissues.

Affected stock, if thawed rapidly in a warm place, or if kept in a moist atmosphere, is soon destroyed by slimy soft rot. Therefore it is not suitable for storage. It is generally assumed that cabbage can be frozen once or twice, if thawed out properly, without any injury except a slight shrinkage and flabbiness. The outer leaves can be frozen and thawed without injury, but if the freezing extends to the interior tender tissues, these are killed and, upon thawing, fall a ready prey to slimy soft rot.

Generally all frozen heads which do not show a glassy, yellowish ring in the tissue of the stalks upon thawing are fit for marketing for immediate consumption. This is not a positive test, however, since not all affected heads show a discoloration or decay of the stalk.

CABBAGE: LEAF SPECK.

Cause: Not known; probably non-parasitic.

Leaf speck consists of small, sharply-sunken, shiny, brown spots or black specks which may occur on all leaves of an affected head. Speck can be differentiated from black leaf spot by the smaller size of the spots, and by the absence of concentric rings, or any black fungous outgrowth.

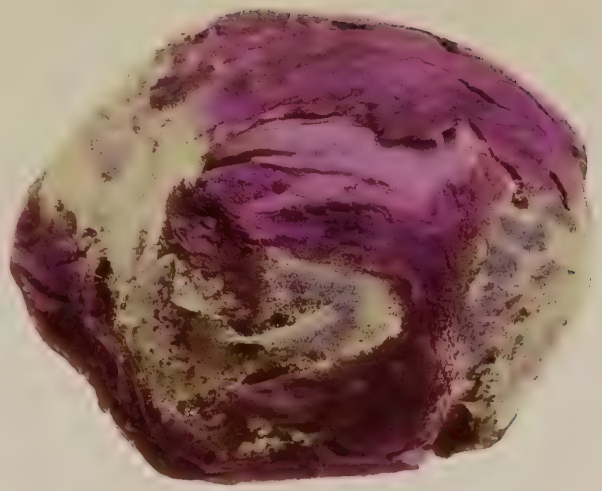
Leaf speck occurs in cabbage from all sections, and is very severe in some Florida stock.

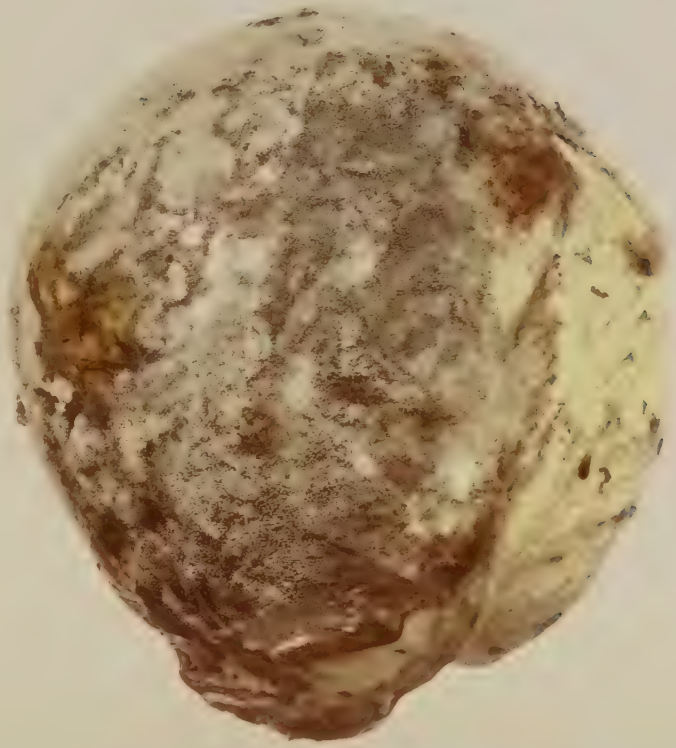
Nothing is known about the cause, point of origin, and conditions favoring the development of the disease.

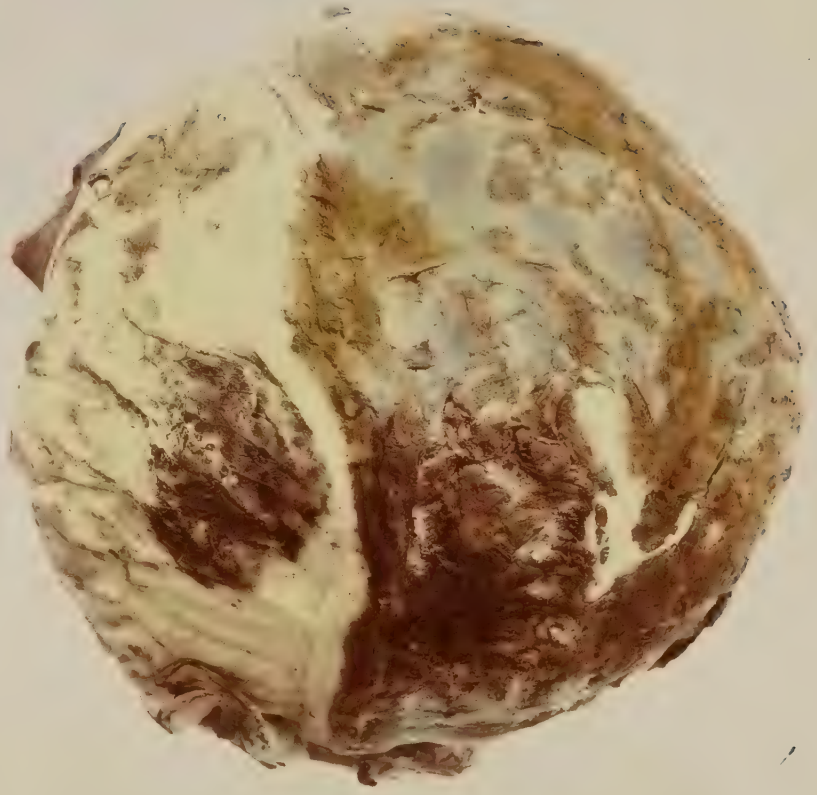
No control measures are known. It is advisable to sort cabbage carefully because affected heads have a lower market value.

CABBAGE: SUN-SCALD.

(See Sun-Scald).







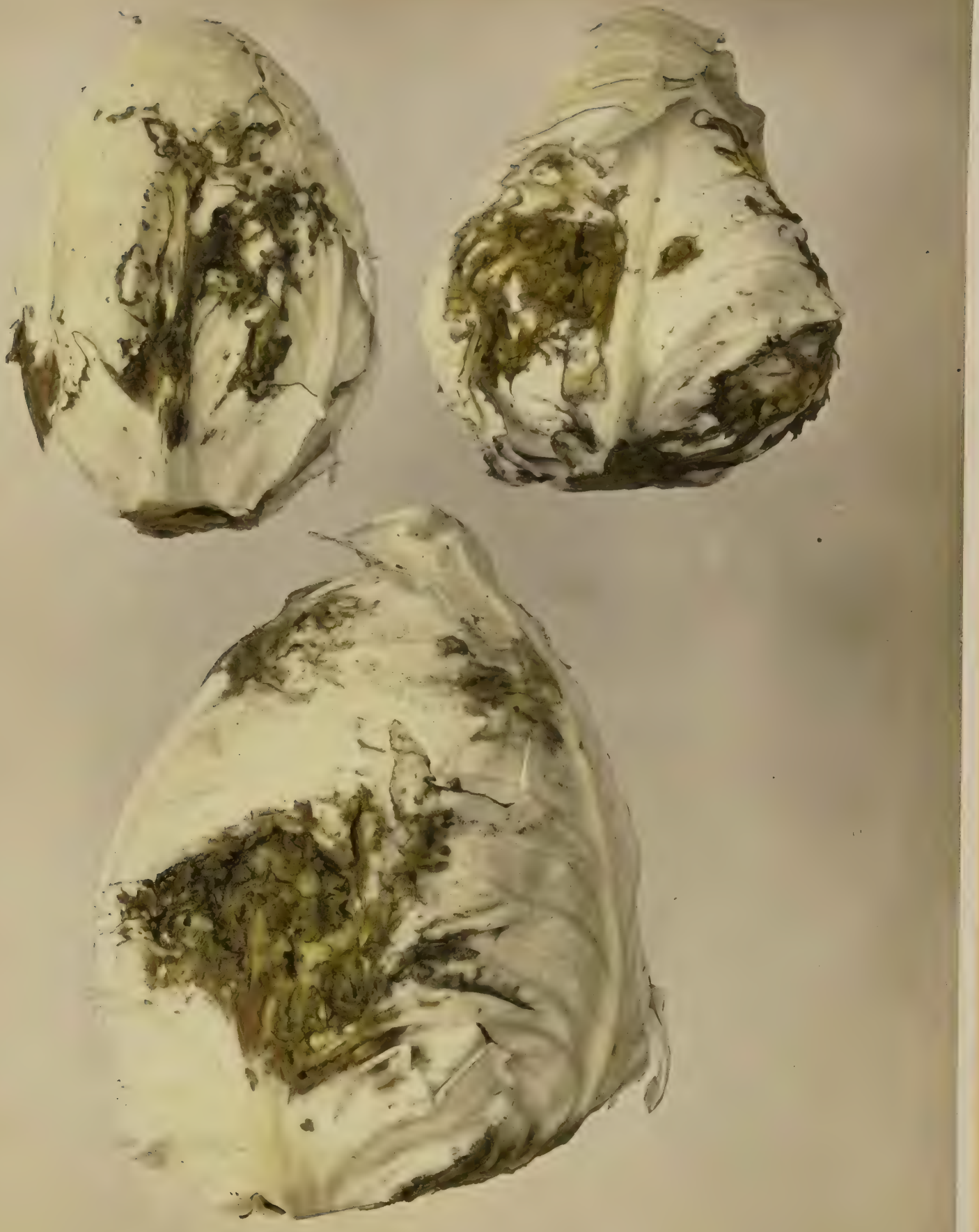
CAB[illegible]MOLD ROT

CABBAGE: GRAY MOLD ROT; BOTRYTIS ROT.

(See Gray Mold Rot).

CABBAGE: RHIZOPUS ROT.

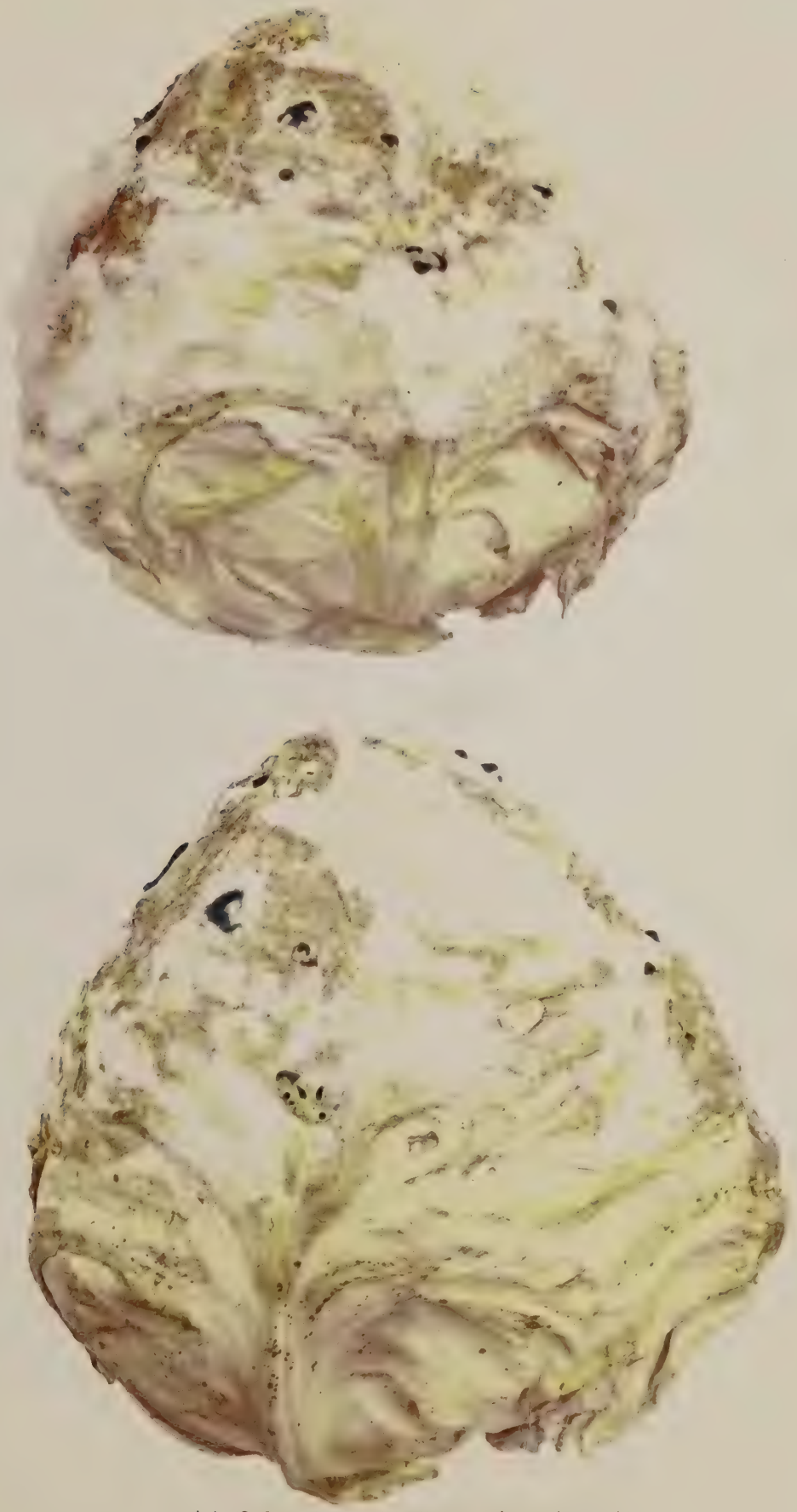
(See Rhizopus Rot).



CABBAGE SOFT ROT.

CABBAGE: SLIMY SOFT ROT; SOFT ROT; BACTERIAL ROT.

(See Slimy Soft Rot).



CABBAGE WATERY SOFT ROT.

CABBAGE; WATERY SOFT ROT; SCLEROTINIA ROT.

(See Watery Soft Rot).

CARROT RHIZOPUS SOFT ROT

CARROT: GRAY MOLD ROT; BOTRYTIS ROT.

(See Gray Mold Rot and Artichoke Gray Mold Rot).

CARROT: RHIZOPUS ROT.

(See Rhizopus Rot).

CARROT: SLIMY SOFT ROT; SOFT ROT.

(See Slimy Soft Rot).

CARROT: WATERY SOFT ROT; SCLEROTINIA ROT.

(See Watery Soft Rot).

CARROT: NEMATODE DISEASE.

(See Nematode Disease).

CAULIFLOWER AND BRUSSELS SPROUTS: RING-SPOT.

Cause: A fungus (Mycosphaerella brassicicola).

The symptoms of this disease of cauliflower are small definitely circular spots on the leaves. They are visible on both sides of the leaf, have light brown or grayish, dry centers, and are surrounded by olive-green or blue-green borders which shade off into the natural color of the leaf. When the leaves turn yellow, the spots retain their green borders and become very conspicuous against the yellow background. The borders of the lesions are frequently raised, and may show concentric circles. Very minute, black dots, pycnidia, cover the outer edges of the spots on both surfaces of the leaves. They are densely crowded in the outer parts of the lesions, but are more scattered or absent in the centers of the spots.

Ring-spot is a field disease on the Pacific Coast. Infection takes place in the field, but the lesions may develop and enlarge during transit.

This disease causes premature yellowing and death of the leaves and thus affects the quality of the stock.

Ref. (52).

CELERY: BACTERIAL LEAF SPOT.

Cause: Bacteria.

This disease is characterized by shiny, dark-brown irregular, translucent or parchment-like spots on the leaves. Often these lesions extend along the veins and down the petioles causing a water-soaked condition. This disease causes a premature yellowing and death of the leaves. The lesions of this disease can be differentiated from the early blight lesions by the ashen gray, opaque centers of the latter and from late blight lesions by the absence of the black shiny dots or pycnidia.

Bacterial leaf spot occurs in Michigan and New York celery.

Infection takes place in the field and the disease may develop, but does not spread in transit or storage.

Severely affected stock is discriminated against because of its unsightliness and because the petiole lesions destroy the edible parts of the plant.

Spraying with Bordeaux will control the disease.

CELERY EARLY BLIGHT

CELERY: EARLY BLIGHT.

Cause: A fungus (Cercospora apii).

Early blight is characterized by irregular, slate-colored spots on the leaves, with ashen-gray to tan centers. These can be distinguished from late blight lesions by their larger size and the absence of the conspicuous black dots or pycnidia. Generally early blight occurs only on the leaves, while late blight occurs very commonly on the petiole as well as on the leaf blade. At times early blight occurs on the petioles as elongated, tan, sunken areas, and causes a wilting and drying out of the leaf and petiole. This disease occurs in all celery districts, but is most common in Florida celery. It is favored by hot, dry weather.

Early blight starts as a field infection, and develops in transit or storage. Unlike late blight, it does not lead to a rot, but causes the tissues to dry out and shrivel.

Severely affected stock is unsightly and its market value is reduced.

Early blight can be controlled by spraying with Bordeaux mixture.

CELERY: GRAY MOLD ROT; BOTRYTIS ROT.

(See Gray Mold Rot).

CELERY LATE BLIGHT.

CELERY: LATE BLIGHT.

Cause: A fungus (Septoria petroselini).

Late blight is characterized by small, irregular, brown spots on the leaf blade and petiole. Under transit conditions, the lesions may be dark green and water-soaked. The centers of the spots bear small, black, glistening dots, the fruiting bodies or pycnidia of the fungus. This disease can be differentiated from early blight and bacterial leaf spot by the presence of the shiny pycnidia and the more common occurrence of spots on the petioles, where the pycnidia are even more conspicuous than on the leaf lesions.

This disease occurs generally in all celery districts, especially in California, Florida, Michigan, and New York. It is favored by cool, moist weather.

The fungus overwinters on the seed and in the soil. Late blight spreads in the field during the growing season, and although the original infection takes place in the field, the disease develops and spreads in transit and storage, leading to a soft rot of the leaf blades and petioles.

Severely affected stock is unfit for market and storage purposes.

Crop rotation, use of disease-free seed, and proper spraying will control the disease. It is advisable to discard severely diseased plants because of the continued development of the disease at low temperatures.

Ref. (11); (55).

CELERY SLIMY SOFT ROT

CELERY: SLIMY SOFT ROT; BACTERIAL ROT.

(See Slimy Soft Rot).

CELERY WATERY SOFT ROT.

CELERY: WATERY SOFT ROT; SCLEROTINIA ROT; FOOT ROT; PINK ROT; RIB ROT.

(See Watery Soft Rot).

CELERY: BLACK HEART.

Cause: Unbalanced water relations.

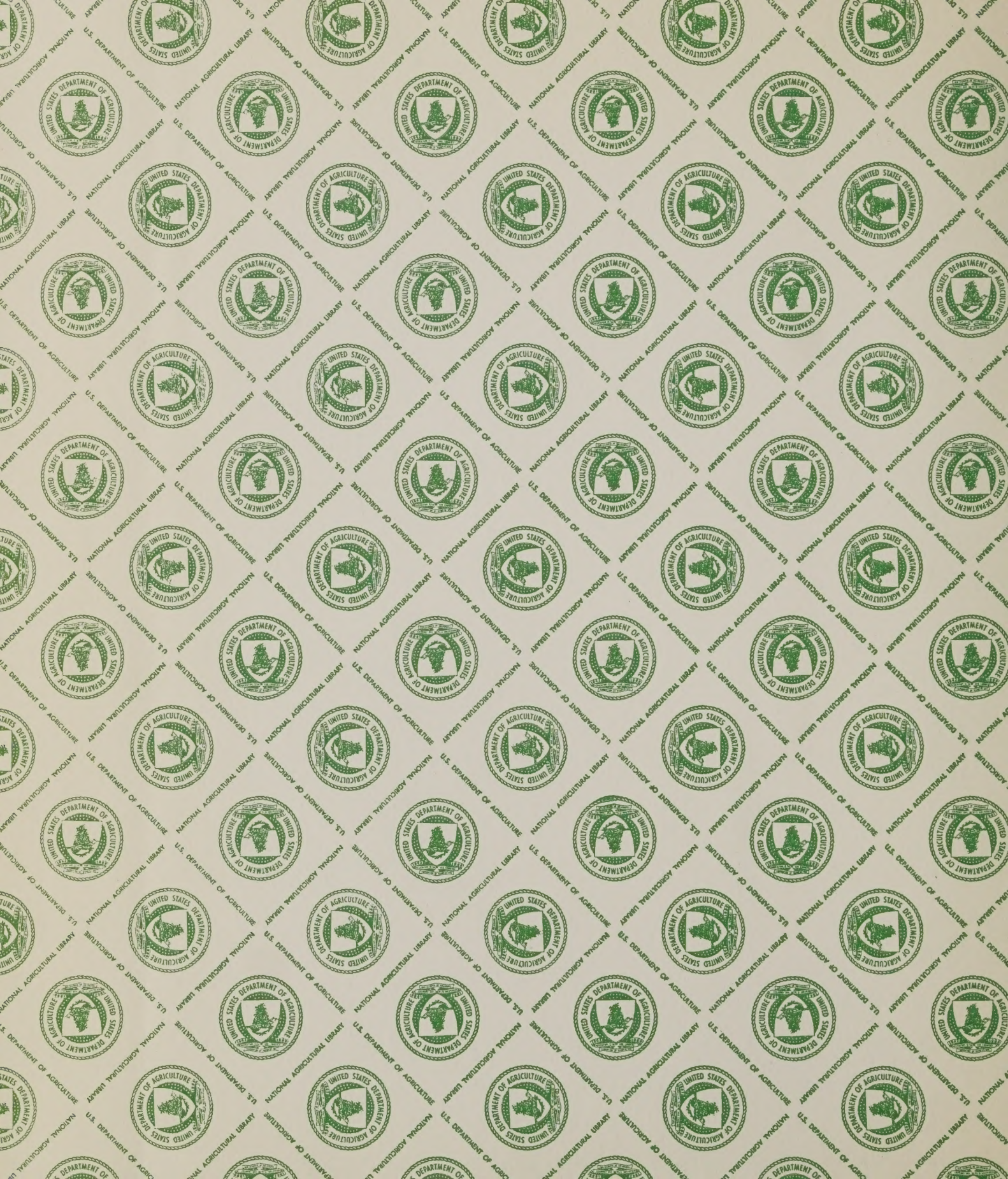
In the earliest stages this disease is marked by shiny, light brown lesions on the blades of the youngest leaves. Very often these are not apparent until the heart of the plant is dissected, since the innermost, most completely protected leaves frequently are the only ones affected. Later the lesions enlarge so as to involve the entire leaf blade, and become very moist and turn black, the whole heart, even the entire stalk, becoming involved if sufficient time is allowed. The advanced symptoms of the disease are caused by bacteria of the Bacillus caratovorus type, which invade the tissue killed by the unbalanced water relations of the plant.

Black heart originates in the field. Its evil consequences are so well realized by shippers that most affected stock is culled out before shipping. Whether or not stock will develop black heart depends upon the plant itself, upon the nature of the soil on which the crop is grown, and upon the weather. In Florida the disease is most severe in late season plants of the Golden Heart variety.

Ref. (60).

CELERY: NEMATODE DISEASE.

(See Nematode Disease).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